Session 3: Diagnostics of High Gravity Objects with X- and Gamma Rays

3-3. AGNs

https://doi.org/10.1017/S007418090011575X Published online by Cambridge University Press

COMPTON REFLECTION IN THE VICINITY OF A ROTATING BLACK HOLE

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Abstract. We study the spectra arising from Compton reflection in the innermost parts of the accretion disk. We emphasize that the so far neglected relativistic distortion of the Compton reflection continuum may strongly affect the derived Fe Kα line shapes.

1. Introduction

X-ray irradiation of the cold accretion disk gives rise to two spectral features commonly seen by *Ginga* and *ASCA* in Seyfert 1 galaxies: (1) a broad reflection continuum peaked around 30 keV, and (2) a fluorescent Fe Kα line around 6.4 keV. Current results from the *ASCA* satellite have shown that the Fe Kα line profile is broad and asymmetric in most of Seyfert 1s, indicating strong relativistic effects which distort the reflected spectrum. The analyses of the line profiles show that most of X-ray emission in Seyfert 1s comes from within 10 Schwarzschild radii. Then, since both the Compton reflection and the fluorescence originate from the same reprocessing matter, the reflected continuum is affected by the gravity/Doppler effects in the same manner as the fluorescence line. This effect, neglected in all up-to-date studies, is very likely to affect the fitted line profile, as the low energy tail of the redshifted reflection continuum may significantly contribute to the continuum below 10 keV and the iron edge. To study the importance of this effect, we have recently developed a model treating self-consistently

K. Koyama et al. (eds.), The Hot Universe, 409-410.

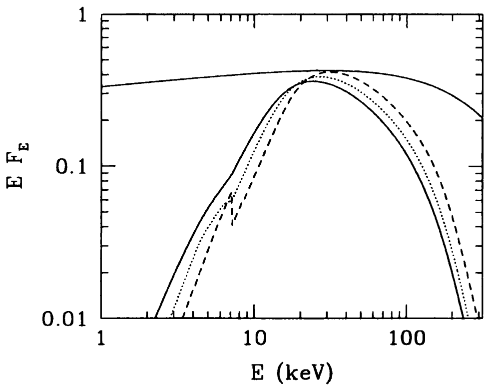

Figure 1. The figure compares the Compton reflected spectra in three different geometries, observed at an inclination angle of $\Theta_{obs} = 30°$. The solid curve corresponds to the Kerr metric for a maximally rotating black hole and the dashed curve corresponds to the Schwarzschild metric. For both cases, we assumed that the bulk of radiation comes from a region within 10 GM/c^2 and that the radial dependence of energy generation follows the emission law $I(r) \propto r^{-3}$. The dotted curve shows the local spectrum of the reflected radiation with no general relativistic transfer effects included. Note the spread of iron absorption edge and strong excess below 10 keV in the reflected spectrum transferred in the Kerr spacetime with respect to the locally generated spectrum. For the Schwarzschild metric the similar effects are less pronounced.

the transfer of the line and the reflection continuum through gravitational field of the black hole with an arbitrary angular momentum (Maciołek-Niedźwiecki, Magdziarz & Zdziarski, in preparation).

2. Results

Figure 1 presents examples of reflected spectra obtained using our model for parameters characteristic for Seyfert 1s (Nandra et al. 1997). For comparison, we also present the spectrum Compton-reflected from a stationary slab (i.e., without taking into account relativistic transfer effects; Magdziarz & Zdziarski 1995). For the Kerr-metric disk relativistic and gravitational shifts of photon energy smear out the bound-free absorption iron edge almost completely, in contrast to the stationary Compton reflection spectrum. The contribution from the innermost radii strongly modifies the shape of the low-energy tail of the reflection continuum integrated over the disk surface. Our results show that the transfer effects have to be taken into account even when modeling broad spectral continuum components.

References

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